ANNEX C

SEVERE WINTER WEATHER
(SNOW, ICE, AND EXTREME COLD)

I. TYPE OF HAZARD

Severe Winter Weather (Snow, Ice, and Extreme Cold)

II. DESCRIPTION OF HAZARD

Severe winter weather, including snowstorms, ice storms, and extreme cold, can affect any area of Missouri. The greatest threat is likely to occur in the area north of the Missouri River, as with the devastating Kansas City area ice storm on January 31, 2002, which stretched into central Missouri and led to a Presidential Disaster Declaration. Severe weather, such as snow, ice storms, and extreme cold can cause injuries, deaths, and property damage in a variety of ways. Winter storms are considered deceptive killers. This is because most deaths are indirectly related to the storm. Causes of death range from traffic accidents due to adverse driving conditions such as icy roads, to heart attacks caused by overexertion while shoveling snow and from other related activities. Hypothermia or frostbite may be considered the most direct cause of death and injury that can be attributed to winter storms or severe cold. Economic costs are also difficult to measure. Heavy accumulations of ice can bring down trees, electric power lines and poles, telephone lines, and communications towers. Such power outages create an increased risk of fire, as home occupants use alternative fuel sources (wood, kerosene, etc. for heat, and fuel-burning lanterns or candles for emergency lighting). These storms can also affect utility and city operations due to debris removal and landfill hauling. In the 2002 ice storm, one home burned when ice-laden tree limbs fell and tore the electrical junction box from the outside of the home. Electrical sparks ignited a blaze that destroyed the home. Crops and trees can be damaged, and livestock can be killed or injured due to deep snow, ice, or severe cold. Buildings and automobiles may be damaged from falling tree limbs, power lines, and poles. Local governments, home and business owners, and power companies were faced with spending millions of dollars to restore services, remove debris, and haul debris. Federal public assistance for local governments and individual assistance for citizens and businesses under Presidential Disaster Declaration MO-DR 1403 helped cover much of the expense. (See storm synopsis under Section III, Historical Statistics.)

The types of watches and warnings during severe winter weather are listed below:

Winter Weather Advisory	Winter weather conditions are expected to cause significant inconveniences and may be hazardous. If caution is exercised, these situations should not become life threatening. Often the greatest hazard is to motorists.
Winter Storm Watch	Severe winter conditions, such as heavy snow and/or ice are possible within the next day or two.
Winter Storm Warning	Severe winter conditions have begun or are about to begin.
Blizzard Warning	Snow and strong winds will combine to produce a blinding snow (near zero visibility), deep drifts, and life-threatening wind chill.

III. HISTORICAL STATISTICS

Weather data indicate that the Missouri counties north of the Missouri River receive an average annual snowfall of 18 to 22 inches. Counties south of the Missouri River receive an annual average of 8 to 12 inches. The events that involve borderline conditions of freezing rain and ice are highly unpredictable. The durations of the more serious events combined with other factors, such as high winds, are also highly unpredictable. The degree of severity may be localized to a small area due to a combination of climatic conditions.

Besides snow and ice, extremely cold temperatures can produce problems. The wind chill is determined by factoring cold temperatures and wind speed (see Table C-1). For example, when the temperature is 20 °F and the wind speed is 15 mph, the resulting wind chill (what it really feels like) is 6 °F. This type of situation can be dangerous to people outdoors because their bodies can experience rapid heat loss and resulting in hypothermia (abnormally low body temperature). Statistical information regarding hypothermia mortality is provided on Figure 2 at the end of this annex.

An indirect winter hazard that affects Missourians every year is carbon monoxide poisoning. Improperly vented gas and kerosene heaters or the indoor use of charcoal briquettes creates dangerous levels of carbon monoxide. In 1997, 31 cases of carbon monoxide poisoning were reported in Missouri. No deaths were reported from these cases.

The following summaries describe some of the more significant severe winter weather events occurring in Missouri in recent years. (This information was taken from the National Weather Service's "Storm Data and Unusual Weather Phenomena" publication.)

February 15-16, 1993: Central and southern Missouri was covered with up to 21 inches of snow. The airport at Cape Girardeau received 6 inches of snow in 1 hour and 20 minutes.

January 14-20, 1994: Northeast, central, and east-central Missouri experienced overnight low temperatures from below zero to –20 °F. Hundreds of homes and businesses had frozen and busted water pipes. Wind chills, which ranged from -30 to -50 °F, kept schools closed and accounted for 15 people being admitted to local hospitals for hypothermia and frostbite.

January 16-17, 1994: A layer of ice up to 2 inches thick formed over sections of southeast Missouri, followed by 6 to 10 inches of snow. Some areas were without power for more than 24 hours. Roofs collapsed due to the heavy weight of snow and ice.

December 6, 1994: Ice accumulations of 0.5 to 1.0 inch were reported across northwest, north-central, and northeast Missouri. Over 75 percent of the residents in this region were without power. Phone and cable television was also out. A few rural areas were without power for at least seven days. The City of St. Joseph was declared a disaster area by Governor Mel Carnahan because of damages totaling nearly $4 million.

January 18-19, 1995: Central Missouri received heavy snows, dumping 19.7 inches over Columbia alone and setting a new 24-hour snowfall record. Parts of I-70, I-44, and other major highways were closed due to drifting snow. Snow fell at such a fast rate that snowplows and graders became stuck. Almost 5,000 birds were killed when several large chicken and turkey barns collapsed. Thousands of people were without power and telephone service. The Jefferson City and Columbia airports were closed for a time. The University of Missouri at Columbia canceled classes for the first time in nearly 17 years. State offices in Jefferson City were also closed.

October 22-23, 1996: An early snowfall hit the Kansas City area, dumping as much as 8.5 inches of heavy wet snow. Approximately 130,000 residences were without power, and an estimated $1.5 million in property damages were reported.

January 10-13, 1997: Northwest and west-central Missouri experienced overnight low temperatures below zero. No record low temperatures were recorded, but winds gusting up to 30 mph produced afternoon wind chills as low as -30 to -50 °F.

April 10-11, 1997: A spring snowstorm dumped up to 24 inches in extreme north Missouri. Schuyler County alone reported $2 million in damages, most due to the heavy snow causing roofs on farm buildings to collapse.

January 31, 2002: A massive severe winter storm system dumped snow and ice from Oklahoma to Kansas and into central and northern Missouri. In Missouri alone, more than 600,000 residents were without power, as ice-encased power lines snapped in fierce winds or were pulled down by falling trees and limbs. Loss of electricity included more than 460,000 people in the Kansas City metro area alone (Jackson, Cass, Clay, and Platte counties). Additionally, residents in a line from Kansas City to the Iowa-Illinois border were without power as rural electric cooperative lines broke as well. Outages ranged from several days to nearly two weeks. Damage to property, power restoration, and the cost of debris removal for local governments was so high that Missouri received a Presidential Disaster Declaration (MO-DR 1403) on February 6, 2002, which ultimately included 43 counties; 26 were designated for both individual and public assistance, and 17 were eligible for individual assistance only. (For a list of all counties declared, see Figure 1 in Section VII.) The total eligible public assistance costs for this disaster ($61.9 million dollars as of August 2002) ranks the 2002 ice storm as Missouri's second most costly disaster to date.

IV. MEASURE OF PROBABILITY AND SEVERITY

It is quite difficult to make an objective and quantitative measure of the probability and severity of snowstorms, ice storms, and extreme cold. Therefore, any analysis should be considered subjective and qualitative.

For areas north of the Missouri River, the probability of a snowstorm, ice storm, or extreme cold should be considered high due to historically higher average snowfall and lower average temperatures. However, the severity is rated moderate due to the overall level of preparedness in this area. For example, homes and businesses may be better insulated due to the higher probability of severe cold relative to other areas. Also, people living in this area may be more likely to use snow tires or purchase four-wheel-drive vehicles. People living in this area may be more likely to maintain adequate supplies of home heating fuels and consider other preparedness measures. Local and state governments may have access to more snow clearing equipment and maintain adequate supplies of materials needed for snow or ice removal. School districts and businesses may be more likely to develop and use snow routes or establish closing procedures.

Areas south of the Missouri River have a low probability of a snowstorm, ice storm, or extreme cold due to their lower average snowfalls and temperatures. However, such events in these areas have a moderate potential severity. This may be due to a lower level of preparedness. People living in this area may have homes with inadequate insulation or fail to maintain an adequate supply of home heating fuels. People may be less likely to equip their vehicles with snow tires or purchase four-wheel-drive vehicles. Local and state governments may not maintain sufficient amounts of equipment and materials. Schools and businesses may not have formal snow routes or closing procedures.

V. IMPACT OF THE HAZARD

People are adversely affected by winter storms, ice storms, and extreme cold, some more than others. Observations by the National Oceanic and Atmospheric Administration (NOAA) indicate that of winter deaths related to exposure to cold, 50 percent were over 60 years old, over 75 percent were male, and about 20 percent occurred in the home. Of winter deaths related to ice and snow, about 70 percent occur in automobiles, and 25 percent are people caught in storms. As noted earlier, ice storms can result in significant economic costs to homeowners, business owners, and utility companies. The ice storm in December 1994 demonstrated the environmental damage that can occur. Thousands of trees and plants were cut down or damaged as a result of the ice storm. The problem of debris clearance caused environmental impacts due to the permitted burning of debris or reduced landfill space.

VI. SYNOPSIS

As noted in this report, snowstorms, ice storms, and extreme cold can interact to cause many hazards. Only a few degrees may be the difference between rain, ice, or snow. Duration and intensity of any of these events will determine the overall impact of a particular event. Wind speed may be the difference between a minor snow or a blizzard. These events cannot be prevented. Preparedness for these events may be the greatest single factor to reduce loss of life, injury, and property damage. NOAA weather broadcasts via radio and television provide important information for people to prepare and thus reduce risks to their lives and property.

VII. MAPS OR OTHER ATTACHMENTS

(MO-DR 1403): Counties declared for individual assistance and public assistance from the January 2002 ice storm are shown on Figure C-1.

Hypothermia: Hypothermia is defined as a cold injury associated with a fall of body temperature to less than 94.1ºF, which results from unintentional exposure to a cold environment. In Missouri, 371 people have died from the cold during the winter months since 1979 when data collection of hypothermia first began in Missouri. There were 28 deaths during the 2002-2003 cold weather season and 20 deaths during the 2003-2004 season (preliminary data).

The elderly are more likely to be victims of cold-related illness resulting in death. Too often handicapped or elderly individuals fall outside their homes and are unable to reach shelter or help. During the cold weather seasons 1989-2004 (preliminary data), 110 (51%) hypothermia deaths were of people age 65 years and older. Deaths of individuals between the ages of 25-64 often have a contributing cause of substance abuse or a debilitating medical condition. Since 1989, there have been 97 (45%) hypothermia deaths in this population. Fortunately, deaths in people age <25 years are rare, accounting for only 7 (3%) of the total 214 Missouri hypothermia deaths for the 1989-2004 (preliminary data).

From cold weather winter seasons 2000 through 2004 (preliminary data), the largest number of deaths were among white males comprising 48% (n=39) of the 81 total cold related deaths. The majority, 46 (57%), of deaths occurred in the non-metropolitan areas of Missouri. Jackson County had 18 (22%) deaths, St. Louis County had 9 (11%), and St. Louis City had 8 (10%) of the total 81 hypothermia deaths since 2000.

New Wind Chill Chart: In 2001, the National Weather Service implemented a replacement Wind Chill Temperature (WCT) index for the 2001-2002 winter season (see Table C-1). The reason for the change was to improve the current WCT index used by the NWS and the Meteorological Services of Canada (MCS, the Canadian equivalent of the NWS), which was based on scientific research and a previous index from 1945.

The new formula makes use of advances in science, technology, and computer modeling to provide a more accurate, understandable, and useful formula for calculating the dangers from winter winds and freezing temperatures. In addition, clinical trials have been conducted, and the results of those trials have been used to verify and improve the accuracy of the new formula. The new WTC index incorporates the following factors:

- Uses wind speed calculated at the average height (5 feet) of the human body's face, instead of 33 feet (the standard anemometer height)
- Is based on a human face model
- Incorporates modern heat transfer theory (heat loss from the body to its surroundings during cold and breezy/windy days)
- Lowers the calm wind threshold to 3 mph
- Uses a consistent standard for skin tissue resistance
- Assumes the worst-case scenario for solar radiation (clear night sky).

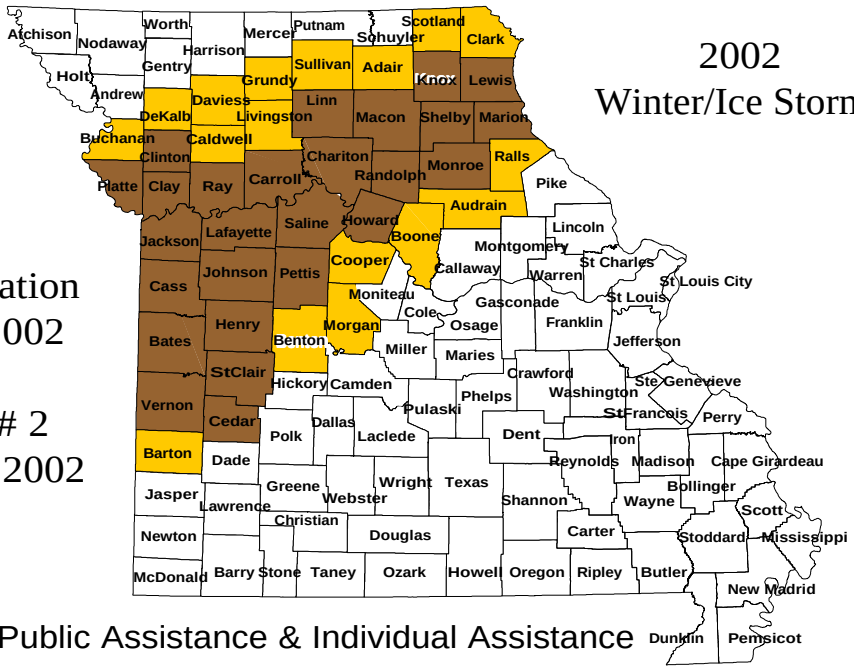
FIGURE C-1

DR-1403 Presidential Declaration

2002
Winter/Ice Storm

Initial Declaration
February 6, 2002

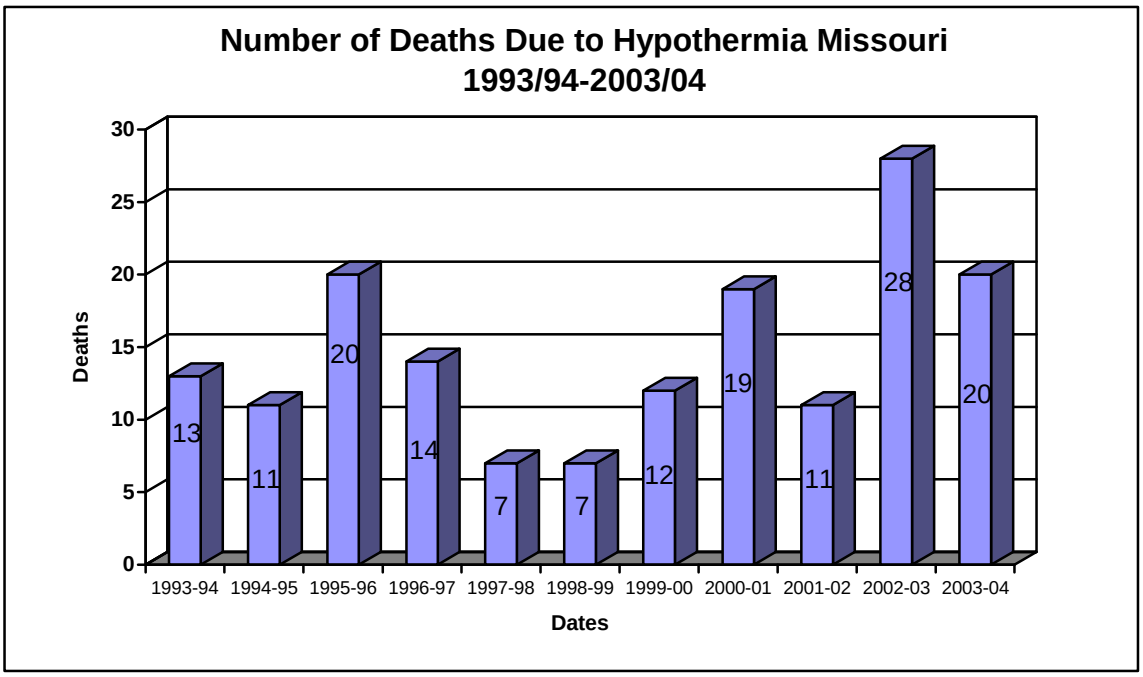
Amendment # 2
February 15, 2002



26 Public Assistance & Individual Assistance

17 Individual Assistance Only

FIGURE C-2



Source: Missouri Department of Health and Senior Services

TABLE C-1

Wind Chill Chart

Wind (mph) \ Temperature (°F)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5		36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10		34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15		32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20		30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25		29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30		28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35		28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40		27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45		26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50		26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55		25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60		25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

VIII. BIBLIOGRAPHY

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